Annals of Clinical and Analytical Medicine
Original Research

Can analgesia with intercostal catheter be an alternative to epidural analgesia for thoracotomy? A prospective study

Pain management for thoracotomy

Cigdem Yıldırım Guclu[1], Başak Ceyda Meco[1], Ahmet Onat Bermede[1], Suheyla Karadag Erkoc[1], Bulent Mustafa Yenıgun[2], Bengi Safak[1], Aysegul Guven[1]
[1] Department of Anesthesiology and ICU
[2] Department of Thoracic Surgery, Faculty of Medicine, Ankara University, Ankara, Turkey

Abstract
Aim: Thoracic epidural analgesia is known as the gold standard for a thoracotomy. An intercostal nerve block may be an alternative, but there are limited data in the literature about analgesia provided by intercostal catheters. This study was designed to compare the efficacy of thoracic epidural analgesia and analgesia provided by an intercostal nerve block in thoracotomy.
Material and Methods: Patients undergoing open thoracotomy were included in the study and divided into two groups. In the intercostal catheter group, the surgeon placed the intercostal catheter into the intercostal space, and in the epidural catheter group, an anesthesiologist placed the epidural catheter at the end of the surgery. A blinded anesthesiologist recorded the postoperative pain follow-up using the visual analog scale (VAS) score at rest, during movement, and during coughing. Standard monitoring and anesthetic protocols were applied to all patients.
Results: In total, 102 patients were included in this study. There was a significant difference between the groups in the VAS values at rest both at 12 and 24 hours (p:0,004). The VAS values during movement showed differences only at the 48th hour of follow-up. The VAS score for chest tube removal time showed no difference.
Discussion: Postthoracotomy pain is one of the most challenging problems for thoracic anesthesiologists and surgeons. Epidural analgesia is the gold standard; however, further studies are needed to prove the effectiveness of alternative methods. The results of this study suggest that an intercostal nerve block with a catheter can be a good alternative to thoracic epidural analgesia.

Keywords
Thoracic Surgery, Postoperative Pain, Intercostal Block, Thoracic Epidural Block

DOI: 10.4328/ACAM.21769 Received: 2023-05-27 Accepted: 2023-07-03 Published Online: 2023-10-14 Printed: 2023-12-01 Ann Clin Anal Med 2023;14(12):1077-1080
Corresponding Author: Suheyla Karadag Erkoc, Department of Anesthesiology and ICU, Faculty of Medicine, Ankara University, Ankara, Turkey.
E-mail: suheylakaradag@hotmail.com P: +90 506 39948 39
Corresponding Author ORCID ID: https://orcid.org/0000-0001-5086-5916
This study was approved by the Ethics Committee of Ankara University Faculty of Medicine (Date: 2018-12-10, No: 20-1370-18)

Introduction

Thoracotomy is one of the most painful surgical procedures performed. Surgical incisions, rib damage, drains, suturing techniques, and chest tubes may cause postoperative pain [1]. Providing analgesia after thoracotomy is essential not only for analgesia but also to aid respiratory mechanics during recovery. Many protocols have been used for postoperative analgesia, including systemic analgesics and regional methods. Although epidural analgesia is known as the gold standard for pain relief after thoracic surgery, it may result in some undesirable systemic effects, such as hypotension. Thoracal epidural analgesia (TEA) has been found to be superior to systemic opioids in terms of pulmonary function and analgesia. However, there are limited data regarding analgesia provided by intercostal catheters in the literature.

An intercostal block (ICNB) is often placed by the surgeon under direct visualization of the nerve bundle at the conclusion of the case as an adjunct in multimodal postthoracotomy analgesia. The short analgesia time limits the use of ICNB because of the high systemic absorption of local anesthetic drugs in the intercostal space. Although ICB has been shown to be superior to systemic opioids alone, it has been found to be inferior to TEA [1].

This randomized prospective, single-center study was designed to compare the postoperative analgesic effects of ICNB and TEA in patients undergoing elective thoracotomy. The main objective of this study was to compare the VAS scores between the two techniques.

Material and Methods

Patients included in the study underwent open thoracotomy over the six-month period after Ethics Committee approval. The exclusion criteria were age <18 years, <40 kg, body mass index (BMI) >35 kg/m^2, bleeding diathesis, opioid use, allergy to drugs to be used in the study and multicostal incisions.

The 102 included patients, aged 18-75 years and classified ASA I-II, were divided into two groups by sequential randomization. The Ethics Committee of the Ankara University University Medical Faculty approved the study protocol (20-1370-18, 10.12.2018) and (the clinical trial number NCT03721250). Written informed consent was obtained from all patients.

Demographic data, preoperative medications, and the surgical and medical histories of the patients were obtained and recorded. In the operating room, standard monitoring was performed using electrocardiography (ECG), noninvasive blood pressure measurement, and oxygen saturation measurement. In addition, bispectral index monitoring was used to ensure standardization for anesthesia maintenance. After induction with fentanyl, lidocaine, propofol, and rocuronium, patients were intubated with a double-lumen tube, and tube placement was controlled with a bronchoscope. Anesthesia was maintained with desflurane at a BIS level of 50-55. During anesthesia maintenance, rocuronium and fentanyl (1 mcg/kg) were administered hourly. During skin incision closure, paracetamol (1 g, IV) was administered to all patients. For the intercostal catheter group (Group ICNB, Group I), the surgeon placed the intercostal catheter in the intercostal space by direct visualization at the end of surgery, which was mostly at T5 level. The incisions were of similar width. For the epidural catheter group (Group TEA, Group II), an anesthesiologist placed the epidural catheter between the T6-8 epidural space and administered the test dose of 40 mg lidocaine. After extubation of the patient, analgesic infusion was started in the intercostal group. In the epidural group, the infusion was started with the movement of the patient's legs to confirm that there was no motor block. The dose of bupivacaine used as an analgesic was set at 400 mg/day for both groups; the infusion rate of analgesic was the same in both groups. To reduce the risk of postoperative nausea and vomiting, 4 mg of ondansetron was administered intravenously at the end of surgery. A blinded anesthesiologist recorded the intraoperative and postoperative data, and postoperative pain was evaluated using the visual analog scale (VAS). Paracetamol, diclofenac, and dolantin were ordered as rescue analgesics when the VAS score was > 4. Catheters in both groups were removed as the chest tube was removed. VAS scores were recorded at rest, during movement, and during coughing at 30 minutes and 1, 2, 6, 12, 18, 24, 48, and 72 hours after the procedure. The amount of each analgesic administered during the postoperative period was recorded. Patients were asked about their satisfaction after catheter removal, in order to get a yes or no answer.

According to a published study using postoperative pain assessed by VAS scores as the primary outcome variable, the expected difference between the means was calculated as 1.2 with a standard deviation of 1.5. Assuming the power of our study to be 80% and an alpha error of 0.05, the sample size was calculated as 45.

The data collected from the patients were entered into Epidata. The VAS pain score data recorded at successive time points (1, 2, 6, 12, 24, and 48 h after surgery) for patients in each group were compared using the Mann-Whitney U test. STATA 11 (Stata Corp., College Station, Texas, USA) was used as the statistical software. The results were considered statistically significant at p <0.05 [2].

Ethical Approval

Ethics Committee approval for the study was obtained.

Results

A total of 102 patients (54 in the ICB group and 48 in the TEA group) were included in this study. The demographic characteristics were similar in the two groups (Table 1).

VAS scores were recorded at rest, during movement, and during coughing at 30 min and at 1, 2, 4, 6, 12, 24, and 48 hours after the procedure. There was no significant difference between the two groups in the use of analgesics in the postoperative period. There was a significant difference among groups in VAS pain scores recorded at rest at the 12th hour (4.5±1.3 for Group 1 and 6.2±2.3 for group 2, P=0.004), 24th hour (2.5±1.6 for Group 1 and 4.4±1.7 for Group 2, P=0.004) and 48th hour (0.8±1.2 for Group 1 and 3.4±1.3 for Group 2, P=0.043) (Table 2).

The VAS values during movement showed differences only at one time interval. At the 48-hour follow-up, the VAS score was 2.6±19 for Group 1 and 4.3±1.4 for Group 2, and the p- value was 0.003. Other recorded VAS values were not significantly different between the two groups (p>0.05) (Table 3).

Cough had a strong impact on pain in the postthoracotomy

patients. According to our results, the patient's pain assessment during coughing did not differ between the groups (p values was > 0,05 in all time periods)

Mean VAS scores during the chest tube removal procedure were statistically different (0.54 ± 1.05 for Group 1 and 0.8±0.8 for Group 2, p=0.043). Patient satisfaction was significantly different between Group 1 and Group 2 (9.15 ± 1.04 and 7.47±1.9, respectively, p=0.00).

There were no statistically significant differences among the groups in terms of the first analgesic requirement (p=0.463), maximum VAS score (p=0.524), or total opioid requirement (p=0.255). No serious catheter-related complications were observed in either group.

Table 1. Demographics of the groups.

	Group 1	Group 2	p
Female/male(n)	28/26	26/22	0,173
Weight (mean)(kg)	73,06±13	76,3±13	0,354
Height (mean)(cm)	167,4±8,5	168±7,8	0,5
Surgery time (min)	250±77,9	278,5±80	0,08
Length of incision (cm)	15,8±2,6	14,06±2,6	0,075

Table 2. VAS scores during follow-up times at rest (mean ±SD).

	Group 1	Group 2	p
VAS rest at 30. min	7,6± 1,4	8,0±1,9	0,08
VAS rest at 1 hour	7,0±1,6	7,7±2,2	0,101
VAS rest at 2 hours	6,2±1,5	7,0±2,1	0,319
VAS rest at 6. hour	5,98±4	6,6±2,6	0,087
VAS rest at 12 hours	4,5±1,3	6,2±2,3	0,004
VAS rest at 18 hours	3,6±1,7	4,9±1,9	0,022
VAS rest at 24 hours	2,5±1,6	4,4±1,7	0,004
VAS rest at 48 hours	0,8±1,2	3,4±1,3	0,043
VAS rest at chest tube removal	0,54±1,05	0,8±0,8	0,043

Table 3. VAS scores during movement (mean ±SD).

	Group 1	Group 2	p
VAS movement at 30 min	8,46± 1,1	8,2±1,8	0,565
VAS movement at 1 hour	8,1±1,3	7,8±2,1	0,91
VAS movement at 2 hours	8,4±1,4	7,5±2,1	0,995
VAS movement at 6 hours	6,6±2,1	7,1±2,2	0,588
VAS movement at 12 hours	5,8±1,7	7±2,3	0,103
VAS movement at 18 hours	4,7±2,1	5,4±2,1	0,374
VAS movement at 24 hours	4±2,1	5±2,1	0,292
VAS movement at 48 hours	2,6±1,9	4,3±1,4	0,003

Discussion

Postthoracotomy pain is one of the most challenging problems for thoracic anesthesiologists and surgeons. Pain related to thoracotomy is due to skin incision, chest wall pleural damage, rib retraction, and chest tubes. Maintaining effective analgesia not only provides pain reduction but also helps recover respiratory dynamics during postoperative period. Epidural analgesia is known to be the gold standard; however, further studies are needed to prove the effectiveness of alternative methods such as intercostal catheter block, which can also provide analgesia during thoracotomy.

This study concluded that intercostal catheters may be an alternative analgesic method in thoracotomies. The study found that placement of the intercostal catheter was easier than placement of the epidural catheter when performed by direct visualization. In addition, intercostal catheters may have been advantageous in terms of potential complications and intercostal blockages did not have systemic effects as concluded in other studies [2].

Many multimodal analgesic regimens have been used, such as nonsteroidal anti-inflammatory drugs, NMDA receptor antagonists, acetaminophen, gabapentinoids, opioids, thoracic epidural analgesia, intercostal nerve blocks, paravertebral blocks, erector spinae plane blocks, and serratus anterior block [1,3]. Intravenous analgesic regimens containing fentanyl alone do not provide sufficient efficacy in preventing postthoracotomy pain, and patients require high-dose rescue analgesics. The effective use of regional techniques is important in multimodal analgesia [4].

Thoracic epidural analgesia was the gold standard until other less invasive methods began to play a role in analgesia management. In addition, adverse events experienced with thoracic epidural have led to the search for an alternative method that provides effective analgesia. In addition to being more invasive, thoracic epidural analgesia has some unwanted side effects, such as intradural puncture, respiratory failure, dura perforation, bradycardia, hypotension, nausea and vomiting, itching, urinary retention, and catheter-related infection [5]. In addition, difficulties may be encountered in epidural catheter placement due to anatomical factors, such as scoliosis or previous spinal operations. Compared with thoracic epidural catheters, intercostal catheter replacement is much easier. Because the intercostal nerve block inhibits intercostal nerve transmission at the distal portion of the intercostal nerve, no systemic side effects are expected.

An intercostal nerve block can be performed at more than one level for postthoracotomy pain, and it can be equivalent to TEA in the first 24 hours. Long-term analgesia can be achieved with continuous infusion of local anesthetic provided by an intercostal catheter. Wurnig et al. showed that TEA was superior to ICNB after the first 24 h. In this study, the VAS scores were similar among the groups, except for three-time intervals. In particular, the VAS values recorded during movement and coughing were similar [6] .

A study by Vilvanathan et al. did not show a statistically significant difference between TEA and ICNB, but opioid infusion was included in their protocol [2]. In our clinical practice, we want to reduce opioid use in postoperative pain

management especially in postthoracotomy patients; therefore, we used opioids only as rescue analgesics.

Debreceni et al. compared ICNB and TEA in thoracotomies and found that the TEA group needed fewer narcotics for breakthrough pain and showed lower VAS scores. They found no differences in pulmonary function between the groups. They concluded that TEA is superior to ICNB after thoracotomies [7]. In the study by Luketich et al., analgesia provided by ICNB was equivalent to that provided by TEA. The absence of the disadvantages encountered with TEA makes ICNB a good alternative [8]. In our study, ICNB was found to be superior at some time intervals, which supports ICNB as an alternative analgesic method.

Rice et al. concluded that ICB is comparable to TEA as an intercostal block for thoracotomy when liposomal bupivacaine is used in ICNB. Liposomal bupivacaine is effective for 72 hours and can be used instead of a catheter. They pointed out that TEA requires monitoring that can incur additional costs [9].

Kawagoe et al. performed a study using robotic thoracic surgery, which compared TEA with ICNB with IV PCA. They found that TEA was superior to ICNB for analgesia [4].

Concha et al. compared 5-segment intercostal block IV PCA morphine with PCA bupivacaine and fentanyl infusions through thoracic epidural catheters. They concluded that an intercostal block with bupivacaine plus intravenous PCA morphine is a good alternative to thoracic epidural analgesia for postthoracotomy pain management [10]. We have studied open thoracotomies, which are more painful than robotic thoracotomies. This difference in pain level between the two types of surgical interventions may be a factor in the superiority of TEA.

A study by Sagiroglu et al. compared TEA and ICNB in postthoracotomy patients that used morphine as rescue medicine. Their results concluded that better pain control was achieved with the thoracic epidural technique [11]. The results of our study showed that, especially during coughing and movement, which may be related to more pain, the ICNB method was as effective as TEA.

During the design period of our study, we decided that continuous pain treatment was crucial for thoracic surgery, that patients require effective analgesia until their chest tube is removed. Therefore, we compared these two continuous methods. In our study, the results showed that continuous ICNB can be as effective as TEA. At some postoperative time periods, ICNB was even superior to TEA.

Limitations

Our study had limitations. Because we prioritized analgesia, there were no hemodynamic records of hypotension, which may be caused by TEA. We did not evaluate the cost, postoperative complications, length of stay, or respiratory dynamics using pulmonary function tests. Also, pain perception of patients may differ, so when assessing pain at the 12th hour, a confusing result was obtained.

Conclusion

In conclusion, postthoracotomy pain management is an important issue for both anesthesiologists and surgeons. Unsatisfactory pain control can ruin all work and may result in chronic pain. Performing ICNB is easier and safer than performing TEA. The results of our study show that analgesia provided by intercostal blockage and maintenance of analgesia with a catheter can be an alternative method to epidural analgesia for thoracotomy.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

Funding: *None*

Conflict of interest

The authors declare no conflict of interest.

References

1. Marshall K, McLaughlin K. Pain Management in Thoracic Surgery. Thoracic Surgery Clinics 2020;30(3):339-46.

2. Vilvanathan S, Kuppuswamy B, Sahajanandan R. A Randomized Control Trial to Compare Thoracic Epidural with Intercostal Block Plus Intravenous Morphine Infusion for Postoperative Analgesia in Patients Undergoing Elective Thoracotomy. Annals of Cardiac Anaesthesia. 2020;23 (2):127-33.

3. Kelsheimer B, Williams C, Kelsheimer C. New Emerging Modalities to Treat Post-Thoracotomy Pain Syndrome: A Review. Mo Med. 2019;116(1):41-4.

4. Kawagoe I, Hayashida M, Satoh D, Kochiyama T, Fukuda M, Kishii J. Postoperative analgesia in patients undergoing robot-assisted thoracic surgery: a comparison between thoracic epidural analgesia and intercostal nerve block combined with intravenous patient-controlled analgesia. Ann Palliat Med. 2021;10(2):1985-93.

5. Leslie K, Myles P, Devereaux P, Williamson E, Rao-Melancini P, Forbes A, et al. Neuraxial block, death and serious cardiovascular morbidity in the POISE trial. Br J Anaesth. 2013;111(3):382-90.

6. Wurnig PN, Lackner H, Teiner C, Hollaus PH, Pospisil M, Fohsl-Grande B, et al. Is intercostal block for pain management in thoracic surgery more successful than epidural anaesthesia? Eur J Cardiothorac Surg. 2002;21(6):1115-19.

7. Debreceni G, Molnár Z, Szélig L, Molnár TF. Continuous epidural or intercostal analgesia following thoracotomy: a prospective randomized double-blind clinical trial. Acta Anaesthesiol Scand. 2003; 47(9):1091-5.

8. Luketich J, Land SR, Sullivian EA, Alvelo-Rivera M, Ward J, Buenaventura PO, et al. Thoracic Epidural Versus Intercostal Nerve Catheter Plus Patient-Controlled Analgesia: A Randomized Study, Ann Thorac Surg 2005;79(6):1845-50.

9. Rice DC, Cata JP, Mena GE, Rodriguez-Restrepo A, Correa AM, Mehran RJ. Posterior Intercostal Nerve Block with Liposomal Bupivacaine: An Alternative to Thoracic Epidural Analgesia. Ann Thorac Surg. 2015;99(6):1953-60.

10. Concha M, Dagnino J, Cariaga M, Aguilera J, Aparicio R, Guerrero M. Analgesia after thoracotomy: epidural fentanyl/bupivacaine compared with inter- costal nerve block plus intravenous morphine. J Cardiothorac Vasc Anesth. 2004; 18(3):322-6.

11. Sagiroglu G, Baysal A, Kiraz O, Meydan B, Taşçı A, Iskender I. Comparison of continuous use of thoracic epidural analgesia and intercostal block for pain management after thoracotomy. Kardiochirurgia i Torakochirurgia Polska/Polish J of Thorac and Cardiovasc Surg. 2013;10(3):244-50.

How to cite this article:

Cigdem Yıldırım Guclu, Başak Ceyda Meco, Ahmet Onat Bermede, Suheyla Karadag Erkoc, Bulent Mustafa Yenıgun, Bengi Safak, Aysegul Guven. Can analgesia with intercostal catheter be an alternative to epidural analgesia for thoracotomy? A prospective study. Ann Clin Anal Med 2023;14(12):1077-1080

This study was approved by the Ethics Committee of Ankara University Faculty of Medicine (Date: 2018-12-10, No: 20-1370-18)